An Evaluation of Contaminant Concentrations in Carp From Utah Lake for 2005

Utah Lake, Utah County, Utah

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Prepared by

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Background and Statement of Issues

The Utah Department of Natural Resources, as part of their June Sucker Recovery Implementation Program, will be removing large amounts of carp from Utah Lake. The objective of this report is to determine if the carp from Utah Lake are fit for human consumption, for use as animal feed, or are safe for other uses. Carp from Utah Lake have been collected and analyzed for chemical contaminants. Fish were analyzed for elements including heavy metals, pesticides, and PCBs. The Utah Department of Natural Resources has requested that the Environmental Epidemiology Program review the data. This report is an evaluation of chemical contaminants in carp from Utah Lake in Utah covering the year of 2005.

Methods

Fifteen carp were collected from Utah Lake. Carp were filleted without the skin. Fillets and the remaining tissue (offal) were homogenized separately. Composites were made from fillets from five fish and offal from five fish each. Each composite contained fish tissue from fish of similar size. The five fish of the first composite had a weight range of 8 pounds, 13 ounces to 10 pounds, 1 ounce. The fish of the second composite weighed between 7 pounds, 12 ounces and 7 pounds, 15 ounces. The third composite contained fish that weighed between 3 pounds, 1 ounce and 5 pounds, 4 ounces. Fish tissue composites were then analyzed for elements and heavy metals, pesticides and PCBs.

Results

All contaminant concentrations are reported as a wet weight concentration in milligrams of contaminant per kg fish tissue (mg/kg). Contaminant concentrations are for the analyzed composite, not individual fish, therefore, the reported values are average concentrations of the contaminant concentrations of all fish in the composite.

Of all the chemical contaminants analyzed, only total PCBs were found to be elevated. Total PCBs were elevated in the fillet composites, 0.0478 mg/kg fish tissue, exceeding the cancer screening value (0.02 mg/kg) for PCBs. Total PCBs were elevated in offal composites, 0.139 mg/kg fish tissue, exceeding both the cancer (0.02 mg/kg) and non-cancer (0.08 mg/kg) screening values. Total PCB concentrations did not correlate with average fish weight or length. Results are presented in Tables 1-4, Appendix A. Calculations for cancer and non-cancer screening values are shown in Appendix B.

Discussion

Screening values (SVs) were developed by the U.S. Environmental Protection Agency (EPA) and are used as standards by which levels of contamination can be compared. Screening values are defined as the concentrations of target analytes in fish tissue that can trigger further investigation and/or consideration of fish advisories for the waterbodies and species where such concentrations occur [EPA 2000b]. The SVs used in this report are for recreational fishers who consume the fish they catch.

PCBs

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). Small organisms and fish in water take up PCBs. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water [ATSDR 2000].

PCBs accumulate at higher concentrations in fatty tissues than in muscle tissue [ATSDR 2000]. Eating only the fillet portions of fish may reduce consumption of PCBs. When compared to predatory fish, higher levels of PCBs are found in bottom-feeders such as carp.

Non-carcinogenic Effects

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Workers exposed to high levels have shown changes in blood and urine that may indicate liver damage. PCB exposure levels in the general population are not likely to result in skin and liver effects [ATSDR 2000].

Women who ate large amounts of fish contaminated with PCBs or who were exposed to large amounts of PCBs in the workplace had babies that had a slightly lower birth weight compared to women not exposed to PCBs. Babies born to women that had eaten PCB-contaminated fish showed abnormal responses on behavioral tests. Some of these problems included a decrease in short-term memory and problems with motor skills. PCBs are not known to cause any structural birth defects. Babies can be exposed to PCBs through breast milk and the fetus can be exposed through transplacental transfer [ATSDR 2000].

Carcinogenic Effects

Studies of workers provide evidence that PCBs were associated with certain types of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate commercial PCB mixtures throughout their lives developed liver cancer [ATSDR 2000].

EPA classifies PCBs as probable human carcinogens (class B2). More than 150 PCBs were analyzed in the fish collected. To measure their health effects, the concentrations of all detected PCBs were totaled and compared to the EPA total PCB screening value [EPA 2000a]. The carcinogenic SV was exceeded for PCBs in both the fillet and offal carp samples analyzed from Utah Lake.

Consumption Limits

Based on the possible carcinogenic effects of PCBs, the consumption limit for carp fillets from Utah Lake for adults is 1 meal per month (8 ounces per month) and 0.5 meals per month (3.6 ounces) for children. Based on higher concentrations of PCBs in the offal, consumption of carp offal is not recommended (meals per month are 0.3 for adults and 0.2 for children). These calculations, shown in the Appendix, are based on several factors/assumptions: a 70 kg body weight for adults and a 16 kg body weight for children; the EPA oral slope factor for PCBs; the average concentrations of PCBs detected; a maximum acceptable risk level for cancer; and an 8 ounce meal size for adults, 4 ounce meal size for children.

The U.S. Food and Drug Administration (FDA) has set regulations for tolerable levels of PCBs in foods and animal feeds. The temporary tolerance level for PCBs in the edible portion (the edible portion excludes head, scales, viscera, and inedible bones) of fish and shellfish is 2 ppm [FDA 2005]. None of the fillet composites analyzed for this report exceeded 2 ppm, the highest level for a fillet composite was 0.063 ppm. The FDA also allows for levels of PCBs in animal feed components of animal origin up to 2 ppm (this includes: fishmeal; other by-products of marine origin; and in finished animal feed concentrates, supplements, and premixes intended for food producing animals). FDA is more restrictive on PCB levels, with a level of 0.2 ppm, in finished animal feed for food-producing animals (except the following finished animal feeds: feed concentrates; feed supplements, and feed premixes). The fillet and offal samples did not exceed either the 0.2 ppm or 2 ppm guidelines for feed.

Conclusions

Carp from Utah Lake exceeded EPA screening values for total PCBs for both fillet and offal samples. Based on these findings, consumption limits were calculated for the fillet and offal portions. Based on the possible carcinogenic effects of PCBs, the consumption limit for carp fillets from Utah Lake for adults is 1 meal per month (8 ounces per month). Calculations based on EPA estimates show that children, pregnant women and women that can become pregnant should not eat carp from Utah Lake. Based on higher concentrations of PCBs in the offal, consumption of carp offal is not recommended (meals per month are 0.3 for adults and 0.2 for children). None of the other contaminants tested, including mercury, lead, selenium, and various pesticides, are at high enough concentrations to pose a public health hazard.

Under the levels of PCB contamination allowed for by the FDA, the carp (as either fillet or offal) from Utah Lake are considered safe for use as animal feed.

Recommendations

- The Utah Department of Health recommends that consumption of carp fillets from Utah Lake be limited to one 8-ounce meal per month for adults. Children, pregnant women, and women that can become pregnant should not consume any carp fillets from Utah Lake.

- The offal of Utah Lake carp should not be consumed due to high levels of PCBs.

- UDOH recommends that if carp is to be used as animal feed, the final feed product should be analyzed for PCB concentrations since whole body carp were not analyzed in this study.

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Appendices

Appendix A - Tables

Table 1. Sampling data for heavy metal contaminants detected in carp fillet composite samples from Utah Lake, Utah (2005).

Analyte	Average Concentration Wet Weight (mg/kg)	Non-Cancer Screening Value (mg/kg)	Screening Value Source*	Cancer Screening Value (mg/kg)
Aluminum	0.67	5,600	ATSDR	NA
Arsenic	0.13	0.84	ATSDR	6.5
Barium	0.08	560	ATSDR	NA
Copper	0.63	28	ATSDR	NA
Iron	13.7	1,150,000	ATSDR	NA
Mercury†	0.06	0.3	EPA Fish	NA
Magnesium	259.3	NA	NA	NA
Manganese	0.15	140	ATSDR	NA
Nickel	0.13	56	ATSDR	NA
Selenium	0.65	20	EPA Fish	NA
Strontium	3.0	5,600	ATSDR	NA
Zinc	12.1	840	ATSDR	NA

Tissue was analyzed for, but did not detect the following elements: boron, beryllium, cadmium, chromium, lead, molybdenum, and vanadium.
* EPA Fish = (EPA 2000a); ATSDR values calculated as shown in Appendix.
† Based on the chronic oral RfD for methylmercury.
NA = Not available.
Health guidelines are not available for lead or magnesium.

Table 2. Sampling data for heavy metal contaminants detected in carp offal composite samples from Utah Lake, Utah (2005).

Analyte	Average Concentration Wet Weight (mg/kg)	Non-Cancer Screening Value (mg/kg)	Screening Value Source*	Cancer Screening Value (mg/kg)
Aluminum	16	5,600	ATSDR	NA
Arsenic	0.2	0.84	ATSDR	6.5
Barium	1.93	560	ATSDR	NA
Chromium	0.13	4,200	ATSDR	NA
Copper	1.08	28	ATSDR	NA
Iron	44.4	1,150,000	ATSDR	NA
Lead	0.13	NA	NA	NA
Mercury†	0.02	0.3	EPA Fish	NA
Magnesium	368.7	NA	NA	NA
Manganese	1.37	140	ATSDR	NA
Nickel	0.48	56	ATSDR	NA
Selenium	0.74	20	EPA Fish	NA
Strontium	78.6	5,600	ATSDR	NA
Zinc	96.5	840	ATSDR	NA

Tissue was analyzed for, but did not detect the following elements: boron, beryllium, cadmium, molybdenum, and vanadium.
* EPA Fish = (EPA 2000a); ATSDR values calculated as shown in Appendix.
† Based on the chronic oral RfD for methylmercury.
NA = Not available.
Health guidelines are not available for lead or magnesium.

Table 3. Sampling data for chemicals detected in carp fillet composite samples from Utah Lake, Utah (2005).

Analyte	Average Concentration Wet Weight (mg/kg)	Non-Cancer Screening Value (mg/kg)	Screening Value Source*	Cancer Screening Value (mg/kg)
Tetrachlorobenzene 1,2,4,5	0.00012	0.84	ATSDR	NA
Tetrachlorobenzene 1,2,3,4	0.00121	NA	NA	NA
Pentachlorobenzene	0.00033	2.24	ATSDR	NA
Hexachlorobenzene	0.00015	3.2	EPA Fish	0.025
alpha-HCH	0.00010	22.4	ATSDR	NA
beta-HCH	0.00006	1.68	ATSDR	NA
gamma-HCH	0.00004	1.2	EPA Fish	0.0307
delta-HCH	0.00029	NA	NA	NA
Heptachlor	0.00014	1.4	ATSDR	NA
Heptachlor Epoxide	0.00009	0.05	EPA Fish	0.0044
TOTAL Chlordane†	0.00183	2.0	ATSDR	0.114
Aldrin	0.00009	0.08	ATSDR	NA
Dieldrin	0.00028	0.2	EPA Fish	0.0025
Endrin	0.00009	1.2	EPA Fish	NA
Pentachloroanisole	0.00016	NA	NA	NA
Chlorpyrifos	0.00013	1.2	EPA Fish	NA
Mirex	0.00005	2.24	EPA Fish	NA
Endosulfan II	0.00012	24	EPA Fish	NA
TOTAL DDT‡	0.01146	2.0	EPA Fish	0.117
TOTAL PCBs	**0.0478**	0.08	EPA Fish	0.02

* EPA Fish = (EPA 2000a); ATSDR values calculated as shown in Appendix.
† Sum of averages for oxychlordane, alpha-chlordane, gamma-chlordane, cis-nonachlor, and trans-nonachlor.
‡ Sum of averages for 2,4'-DDE, 4,4'-DDE, 2,4'-DDD, 4,4'-DDD, 2,4'-DDT, 4,4'-DDT.
Values in bold exceed one or more screening value.
NA = Not available.

Table 4. Sampling data for chemicals detected in carp offal composite samples from Utah Lake, Utah (2005).

Analyte	Average Concentration Wet Weight (mg/kg)	Non-Cancer Screening Value (mg/kg)	Screening Value Source*	Cancer Screening Value (mg/kg)
Tetrachlorobenzene 1,2,4,5	0.00021	0.84	ATSDR	NA
Tetrachlorobenzene 1,2,3,4	0.0228	NA	NA	NA
Pentachlorobenzene	0.00043	2.24	ATSDR	NA
Hexachlorobenzene	0.00044	3.2	EPA Fish	0.025
alpha-HCH	0.00011	22.4	ATSDR	NA
beta-HCH	0.00009	1.68	ATSDR	NA
gamma-HCH	0.00004	1.2	EPA Fish	0.0307
delta-HCH	0.00412	NA	NA	NA
Heptachlor	0.00038	1.4	ATSDR	NA
Heptachlor Epoxide	0.00035	0.05	EPA Fish	0.0044
TOTAL Chlordane†	0.00525	2.0	ATSDR	0.114
Aldrin	0.00006	0.08	ATSDR	NA
Dieldrin	0.00087	0.2	EPA Fish	0.0025
Endrin	0.00006	1.2	EPA Fish	NA
Pentachloroanisole	0.00054	NA	NA	NA
Chlorpyrifos	0.00022	1.2	EPA Fish	NA
Mirex	0.00014	2.24	EPA Fish	NA
Endosulfan II	0.00026	24	EPA Fish	NA
TOTAL DDT‡	0.045	2.0	EPA Fish	0.117
TOTAL PCBs	**0.139**	0.08	EPA Fish	0.02

* EPA Fish = (EPA 2000a); ATSDR values calculated as shown in Appendix.
† Sum of averages for oxychlordane, alpha-chlordane, gamma-chlordane, cis-nonachlor, and trans-nonachlor.
‡ Sum of averages for 2,4'-DDE, 4,4'-DDE, 2,4'-DDD, 4,4'-DDD, 2,4'-DDT, 4,4'-DDT.
Values in bold exceed one or more screening value.
NA = Not available.

Appendix B - Screening Value and Consumption Limit Calculations

Screening Value and Consumption Limit Calculations

For Noncarcinogenic Health Effects

$SV = [(MRL)(BW)]/CR$

SV = Screening value for a contaminant (in mg/kg or ppm)
MRL = Minimal risk level (in mg/kg/day)
BW = Mean body weight of the general population or subpopulation of concern (kg)
CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

For Carcinogenic Health Effects

$SV_c = [(RL/SF)*BW]/CR$

SV_c = Screening value for a carcinogen (in mg/kg or ppm)
RL = Maximum acceptable risk level (1/100,000 dimensionless)
SF = Oral slope factor $(mg/kg/d)^{-1}$
BW = Mean body weight of the general population or subpopulation of concern (kg)
CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

Consumption Rate Calculations for Non-Carcinogenic Health Effects

To calculate the maximum allowable fish consumption rate for a non-carcinogen:

$CR_{lim} = [(RfD)(BW)]/C_m$

Where:
CR_{lim} = maximum allowable fish consumption rate (kg/day)
RfD = reference dose (EPA) or minimal risk level (ATSDR)
BW = mean body weight of the general population or sub-population of concern (kg)
C_m = measured concentration of chemical contaminant in a given species of fish (mg/kg)

$CR_{mm} = [(CR_{lim})(T_{ap})]/MS$

Where:
CR_{mm} = maximum allowable fish consumption rate (meals/month)
CR_{lim} = as calculated above
T_{ap} = time averaging period (365.25 days/12 months = 30.44 days per month)
MS = meal size (0.227 kg fish/meal for adults, 0.113 kg fish/meal for children)

Assumptions for Consumption Rate Calculations are as follows:
An average adult weighs 70 kg and eats 227 g of fish per meal.
An average child weighs 16 kg and eats 113 g of fish per meal.

Consumption Rate Calculations for Carcinogenic Health Effects

To calculate the maximum allowable fish consumption rate for a carcinogen:

$CR_{lim} = [(ARL)(BW)]/[(CSF)(C_m)]$

Where:

CR_{lim} = maximum allowable fish consumption rate (kg/day)
ARL = maximum acceptable risk level (dimensionless) = 1/100,000
BW = mean body weight of the general population or sub-population of concern (kg)
CSF = oral slope factor $(mg/kg/d)^{-1}$
C_m = measured concentration of chemical contaminant in a given species of fish (mg/kg)

$CR_{mm} = [(CR_{lim})(T_{ap})]/MS$

Where:

CR_{mm} = maximum allowable fish consumption rate (meals/month)
CR_{lim} = as calculated above
T_{ap} = time averaging period (365.25 days/12 months = 30.44 days per month)
MS = meal size (0.227 kg fish/meal for adults, 0.113 kg fish/meal for children)

Assumptions for Consumption Rate Calculations are as follows:

An average adult weighs 70 kg and eats 227 g of fish per meal.
An average child weighs 16 kg and eats 113 g of fish per meal.